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EFFECT OF CONDENSER-DRUM COVERING ON GIN EXHAUST EMISSIONS AND COTTON-LINT QUALITY

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EFFECT OF CONDENSER-DRUM COVERING ON GIN EXHAUST EMISSIONS AND COTTON-LINT QUALITY

By Joe D. Anderson and Roy V. Baker[1]

ABSTRACT

A standard lint-cleaner condenser drum was covered with 105-mesh-wire bolting cloth and compared to an identical uncovered condenser drum to determine the magnitude and nature of condenser emissions to the atmosphere. These comparisons were made while processing stripper-harvested cotton at two ginning rates and condenser speeds, resulting in two batt weights on the condenser drums. The covered drum reduced condenser emissions 35 and 30 percent for low and normal batt weights. Increasing the batt weight on the uncovered drum from low to normal reduced emissions approximately the same amount. Particle size analyses of the condenser emissions showed that neither the fine-mesh covering nor the batt weight had much effect on emitted particles less than 125 micrometers in size, but they significantly reduced emissions of particles more than 125 micrometers in size. These larger particles consisted primarily of fly lint. The fine-mesh covering had no significant effect on the fiber properties studied in the test. However, differences attributable to batt weight were noted. **KEYWORDS: Condenser-drum covering, cotton-lint quality, dust and fly-lint emissions, stripper-cotton ginning.**

INTRODUCTION

Fly-lint emissions from a lint-cleaner condenser can be controlled by covering the condenser drum with finely woven screen wire or by replacing the standard drum covering with one containing smaller openings. McCaskill and Moore[2] reported that this method reduced total condenser emissions approximately 50 percent in tests with machine-picked cotton. Their emission measurements included both fly lint and dust. Since specially covered condenser drums are more effective for controlling fly lint than for controlling dust, their efficiency in other situations will vary depending upon the relative percentages of fly lint and dust in the cotton being ginned.

Little information is available on the performance of specially covered condenser drums operating in gins processing stripper-harvested cotton or the effect of the drum covering on dust emissions. In order to provide information in these areas of interest, tests were conducted at Agricultural Research Service's South Plains Ginning Research Laboratory, Lubbock, Tex., to measure the effects of drum covering on condenser emissions from stripper cotton, size characteristics of dust emissions, and lint quality.

METHODS AND MATERIALS

The tests consisted of comparing two 20-inch-diameter condenser drums, one a conventional

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[2] McCaskill, O. L., and Moore, V. P. Elimination of lint fly, a progress report. The Cotton Gin and Oil Mill Press, Dec. 31, 1966, pp. 5–7.

TABLE 1.—*Exhaust volumes, air-to-lint ratios, total emissions, and control efficiencies for conventional and covered drums at two batt weights*[1]

Type of condenser drum and batt weight	Condenser exhaust volume (m^3/min)	Air-to-lint ratio (m^3/kg)	Total emission[2] (g/bale)	Control efficiency[3] (pct)
Conventional drum:				
Low batt weight	128.8	13.8	542a	...
Normal batt weight	127.4	8.7	361b	...
Covered drum:				
Low batt weight	126.5	13.5	355b	35
Normal batt weight	125.7	8.6	253c	30

[1] Average of 3 replications.

[2] Means followed by different letters are significantly different at the 0.05 level.

[3] $\text{Control efficiency} = 100\left(1 - \dfrac{\text{emissions of covered drum}}{\text{emissions of conventional drum}}\right).$

drum and the other a drum covered with finely woven stainless-steel screen. The two condenser drums were on identical unit lint cleaners behind a high-capacity gin stand. The surface of the conventional drum was perforated metal with 0.109-inch-diameter openings; there were 47 openings per square inch, with an open area of 45 percent. The other drum was identical to the conventional drum except for a fine-mesh covering over the perforated-metal surface. The covering was mesh-wire (105 × 105) bolting cloth with 0.0065-inch-square openings (165 μm), with a 46.9-percent open area. The resulting open area of the specially covered drum was 21.1 percent.

The tests were conducted by alternately operating each condenser in the first stage position. Two lint batt weights, low and normal, were used for a basis of comparison in the experiment. The low-density batt weighed 103 g/m^2 and was obtained with a ginning rate of 2.58 bales/h and a condenser speed of 37 revolutions per minute (r/min). The normal batt weighed 214 g/m^2 and was obtained with a ginning rate of 4.04 bales/h and a condenser speed of 28 r/min.

Air samples were collected isokinetically from the lint-cleaner exhaust line to determine the emissions of each condenser drum. A modified high-volume air sampler was used to extract approximately 50 ft^3/min of air from the condenser exhaust line. The sampled air passed through a type A glass-fiber filter that collected the airborne dust and fly lint. Isokinetic conditions were maintained by using a variable-speed control on the air-sampler motor and by monitoring air velocities in the condenser exhaust and air-sampling nozzle.[3] Total emissions per standard 480-pound bale were determined by the equation

$$E = \frac{SVL}{v480}$$

where E=total emissions (grams per bale),
S=emission sample weight (grams),
V=total air volume of condenser exhaust (cubic feet per minute),
v=sampled air volume (cubic feet per minute),
and L=weight of lint ginned (pounds).

After the filters were weighed and the emissions were determined, the collected material was brushed from the filters and subjected to a sieve analysis to determine particle size distribution. The sieve analysis was accomplished by means of a sonic sifter and sieves with openings of 10, 20, 30, 44, 63, 88, and 125 μm.

The test cotton was a composite cross of a number of commercial and experimental stripper-cotton varieties and lines. The moisture content of the cotton was uniform at the trailer (7.75 percent) and after lint cleaning (6.25 percent). The foreign-matter content at the trailer was within the normal range for stripper cotton; it averaged 31 percent (17.9 percent burs, 9.4 percent sticks, and 3.7 percent

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[3] Parnell, C. B., and Baker, R. V. 1973. Particulate emissions of a cotton gin in the Texas stripper area. U.S. Dep. Agric. Prod. Res. Rep. No. 149, pp. 5–6.

TABLE 2.—*Dust and fly-lint emissions from conventional and covered drums at two batt weights*[1]

Type of emission and condenser drum	Emission[2] Low batt weight (g/bale)	Emission[2] Normal batt weight (g/bale)	Average emission (g/bale)
Dust (less than 125 μm):			
Conventional drum	289	274	282a
Covered drum	343	242	293a
Average, both drums	316a	258a	...
Fly lint (more than 125 μm):[3]			
Conventional drum	253	87	170b
Covered drum	12	11	12a
Average, both drums	133b	49a	...

[1] Average of 3 replications.

[2] Averages for a given type of emission followed by different letters are significantly different at the 0.05 level.

[3] Even though emitted particles larger than 125 μm consisted primarily of fly lint, some larger particles of vegetative origin were also present.

fine trash). After passing through a typical seed-cotton cleaning system the foreign-matter content at the feeder averaged 3.8 percent (1.5 percent burs, 1.2 percent sticks, and 1.1 percent fine trash).

Lint samples were taken after the condensers (before the lint-cleaner feed works) for fiber-quality evaluations and fine-dust content. After the test lint cleaners and another stage of conventional lint cleaning, additional lint samples were taken at the press for fiber-quality evaluations. The fine-dust content of the lint was determined by a dust analyzer presently under development at this laboratory.

RESULTS

Condenser emissions were affected by the type of condenser-drum covering and by the batt weight (table 1). The condenser drum covered with the mesh screen reduced condenser emissions 35 and 30 percent for the low and normal batt weights. It is interesting to note that increasing the batt weight on the conventional drum from low to normal reduced per bale emissions about as much as the covered drum did. The total emissions per bale were highest with the low batt weights for both condenser drums. The reason why the batt weights caused differences in emission was not determined by this study. Factors that may have influenced these results were air-to-lint ratios, batt thickness, and percentage of lint actually coming in contact with the condenser-drum surface.

There were no statistically significant differences between batt weights or condenser drums in the amounts of emitted dust particles less than 125 μm in size (table 2). However, there was a tendency for the low-weight batts to produce the highest dust emissions for both drums. The dust emissions (averages of both drums) were 316 and 258 g/bale for the low and normal batt weights, and the average emissions were 282 and 293 g/bale for the conventional and covered drums. The emissions of particles greater than 125 μm in size (which consisted primarily of fly lint) were significantly reduced by the mesh covering and were generally less for the normal batt weight than for the low batt weight. The average fly-lint emissions were reduced from 170 to 12 g/bale by the mesh covering. Increasing the batt weights reduced emissions (averages of both drums) from 133 to 49 g/bale. Fly-lint emissions appeared to be affected more by condenser covering than by batt weight.

Particle size distributions of the dust emissions from all four test treatments are given in table 3. These size distributions are similar except for slightly higher percentages of dust in the less than 10-μm and 10- to 20-μm size ranges for the low batt weights. The similarity in the distributions is further illustrated by the cumulative distribution plots shown in figure 1. Since

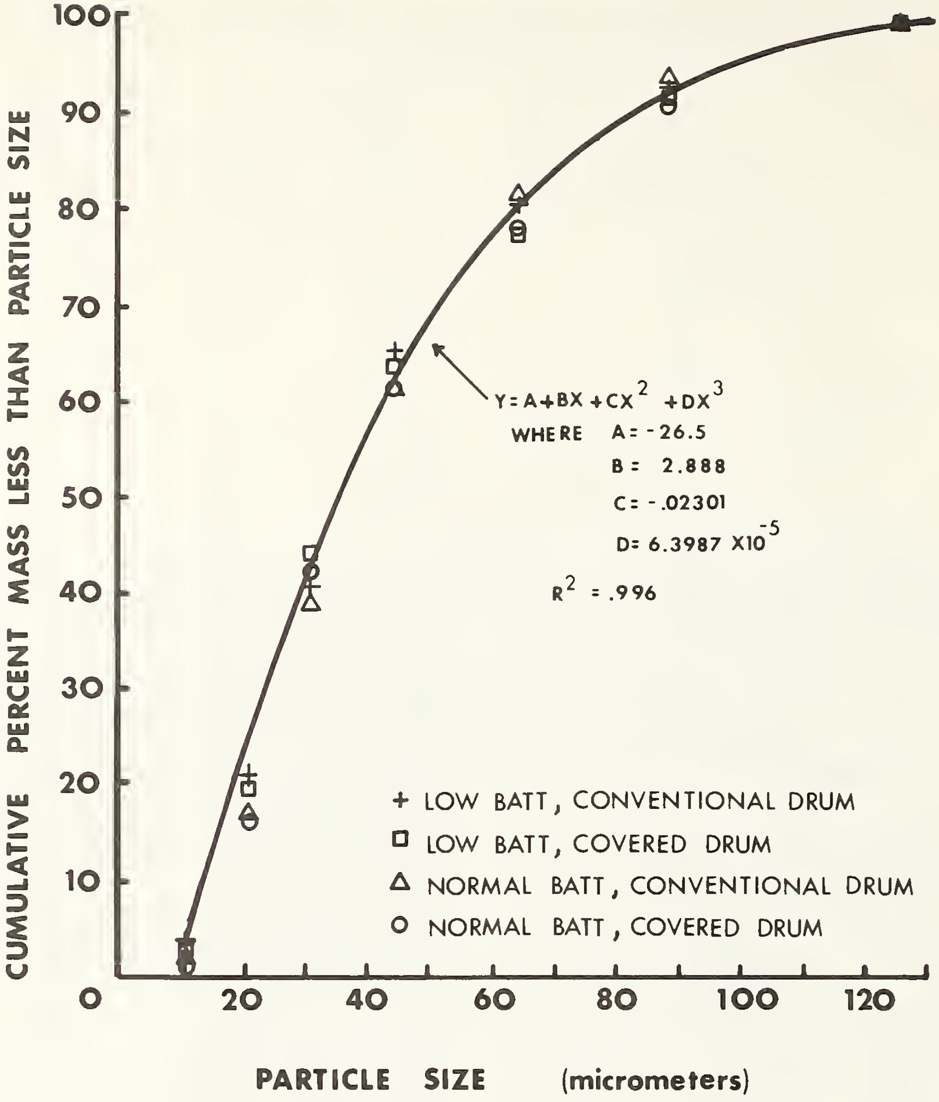

FIGURE 1.—Cumulative size distribution of emitted dust particles less than 125 micrometers in size.

all plots were of essentially the same form, a single regression line was fitted to all the points to represent the particle size distribution of the condenser dust examined in this experiment. The median particle size, based on mass percentages, was approximately 35 μm.

Dust analyses of lint samples taken after the test condensers and before the lint-cleaner feed works showed no significant differences attributable to either condenser covering or batt weight (table 4). The dust content ranged from 16.3 to 18.6 mg per 10 g of lint. These analyses were restricted to dust particles less than 100 μm in size.

The fiber-quality data showed significant differences in nonlint content before and after lint cleaning and in 2.5-percent span length after lint cleaning. The differences in nonlint content occurred between batts, not between condenser drums. The differences between the batts were probably attributable to the two ginning rates required to produce their weights. The slower ginning rate would normally be expected to enhance cleaning by the feeder and gin stand, which might account for the lower nonlint contents for the low-density batt. The 2.5-percent span length after lint cleaning also showed a significant difference between the batts and can

TABLE 3.—*Particle size distributions of emitted dust particles less than 125 micrometers in size*[1]

Particle size range (μm)	Percentage of dust			
	Low batt weight		Normal batt weight	
	Conventional drum	Covered drum	Conventional drum	Covered drum
less than 10	2.4	1.8	1.6	1.6
10 to 19	18.1	18.2	16.5	15.9
20 to 29	20.4	24.7	21.2	24.9
30 to 43	24.8	18.9	22.4	19.3
44 to 62	15.1	14.0	20.3	16.4
63 to 87	12.8	14.6	12.2	13.7
88 to 124	6.4	7.8	5.8	8.2

[1] Each distribution is the average of 3 replications as determined by the sieve analysis.

TABLE 4.—*Dust analysis and fiber-property evaluations for conventional and covered drums at two batt weights*[1]

Measurement	Low batt weight		Normal batt weight	
	Conventional drum	Covered drum	Conventional drum	Covered drum
Dust content per 10 g of ginned lint[2] mg	16.3	17.5	18.6	17.4
Nonlint content:				
Before lint cleaning pct	8.3a	8.6a	11.2b	10.9b
After lint cleaning pct	4.4a	4.2a	5.3b	5.5b
2.5-pct span length:				
Before lint cleaning inch	0.98	0.97	0.97	0.98
After lint cleaning inch	0.97bc	0.98c	0.95a	0.95ab
Length uniformity:				
Before lint cleaning pct	45	45	46	45
After lint cleaning pct	44	45	45	44
Reflectance value:				
Before lint cleaning R_d	76.3	77.3	75.0	75.8
After lint cleaning R_d	79.1	79.4	78.5	79.1
Yellowness value:				
Before lint cleaning $+b$	8.4	8.4	8.4	8.3
After lint cleaning $+b$	8.6	8.6	8.6	8.6
Grade index:				
Before lint cleaning	89	89	90	89
After lint cleaning	95	95	94	94
Staple length:				
Before lint cleaning 32d inch	31.2b	30.8ab	30.3a	31.0b
After lint cleaning 32d inch	31.9	32.0	31.9	31.7
Micronaire value:				
Before lint cleaning	3.9	3.8	4.0	3.9
After lint cleaning	3.8	3.9	3.9	3.8

[1] Average of 3 replications. Means in a row followed by different letters are significantly different at the 0.05 level.

[2] Ginned lint samples taken between test condensers and lint-cleaner feed works. Averages refer to dust particles of less than 100 μm in size.

be explained by the combination of ginning rates and lint-cleaner combing ratios used to produce their weights. Although the fiber data does show some significant differences between the batt weights, there were no differences due to condenser drums.

The staple-length determinations before lint cleaning showed some significant differences, but these differences were not consistent among treatments. Staple-length determinations of stripper-cotton samples taken before lint cleaning are generally not as accurate as those of lint-cleaned samples. For this reason, and since no differences were found in 2.5-percent span lengths, differences in staple lengths before lint cleaning were discounted. Therefore, there were no consistent differences in staple length, grade, or micronaire reading due to any of the experimental treatments.

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